Identification of outstanding technical issues associated with western US regional ozone and haze

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Western States Air Quality Modeling Workshop

Boulder, Colorado, May 11-15, 2015

Key Challenges

- Background O3 levels might approach or exceed the NAAQS on some days at high elevation western sites:
    - Background O3 levels are highly variable in space and time.
    - Policy mechanisms are available to exclude high background days if we can quantify the sources that cause high O3.
    - Tools to evaluate contributions include global to urban scale photochemical models, trajectory models, regression models and other data analysis methods.
    - How accurately can current tools quantify the sources of O3?
    - How much can we improve these tools with new R&D?
    - What additional monitoring data is needed to support these evaluations?
- Regional haze goal is to achieve natural visibility conditions, so many of these questions are also relevant to $PM_{2.5}$ at Class I areas.

Five Ozone Planning Needs

1. **O3 NAAQS planning** – requires photochemical modeling for SIP attainment demonstrations.
2. **O3 transport SIPs** –photochemical source apportionment modeling can be used to quantify US interstate O3 transport.
3. **Identification of O3 exceptional events caused by stratospheric intrusion and wildfires** – requires observations & data analysis, supplemented with global/regional scale photochemical models and regression models.
4. **Identification of international transport of O3 for 179B demonstrations**: requires nested global and regional scale photochemical modeling to evaluate international transport of O3.
5. **Identification of Rural Transport Areas** – combination of data analysis and photochemical modeling.

Regional Haze & AQRV Planning Needs

- Regional Haze Rule: Goal is to achieve natural visibility conditions in 156 Class I areas by 2064.
  - States must prepare Regional Haze plans due in 2018 or 2021.
  - Need improved estimates of "typical" natural visibility and identification of poor visibility conditions caused by extreme natural events including wild fires and dust storms.
  - How accurately does the coupled global/regional model simulate international and inter-state contributions to visibility impairment at Class I areas?
- Air Quality Related Values (AQRV) include nitrogen and acid deposition at Class I and sensitive Class II areas.
  - Models often perform poorly for ambient NHx and N deposition.
  - To what extent is N deposition error caused by uncertainty in NH3 emissions versus NHx deposition and re-volatilization?

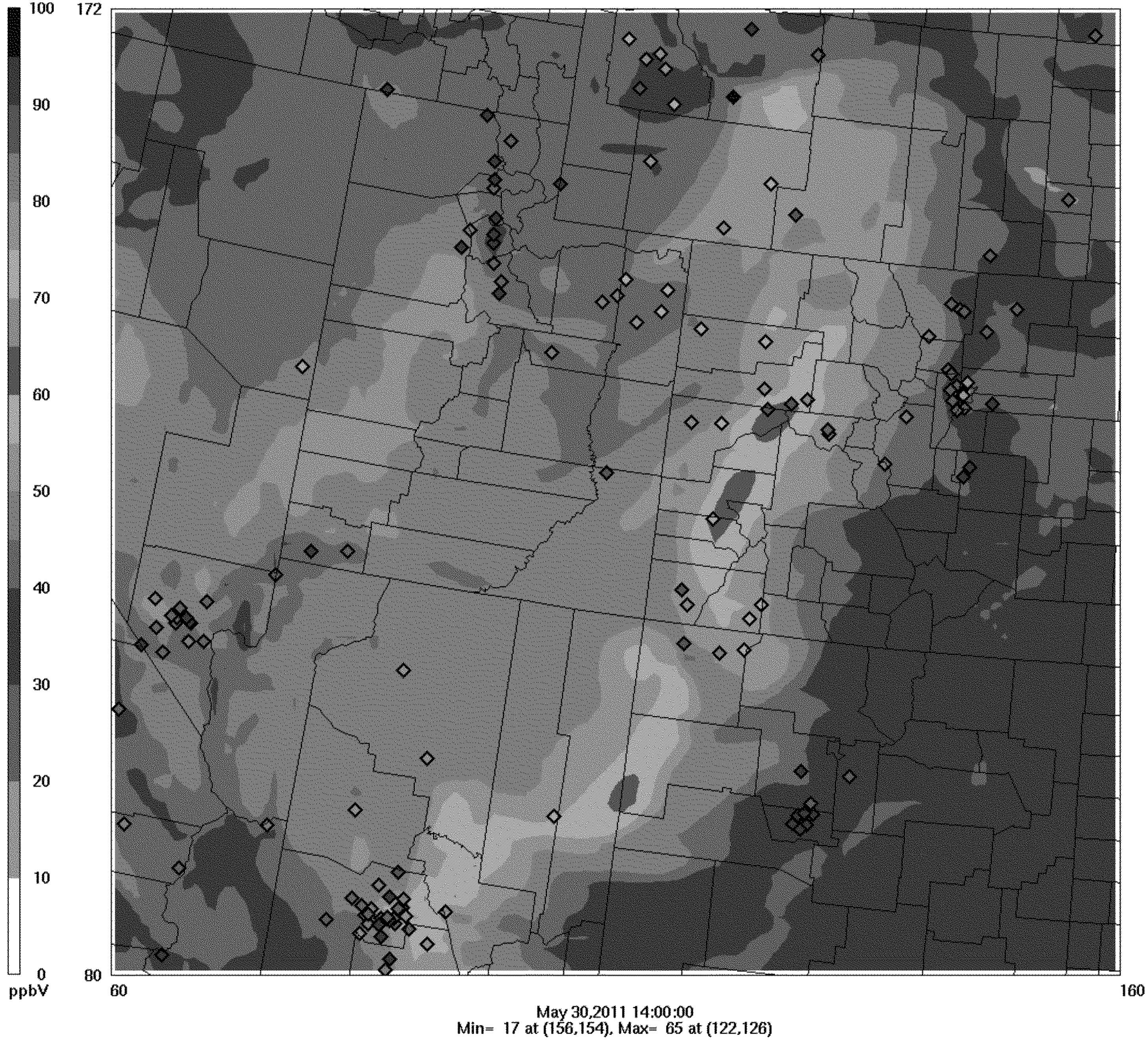
Model Performance Evaluation Goals

- Episode Selection: the MPE should focus on the individual sites and days most relevant to planning needs:
  - Days that exceed the NAAQS are most relevant.
  - Spring days with high background O3 are less relevant if they do not exceed the NAAQS.
  - Less need for modeling of days clearly affected by exceptional events, more research needed for days on which sources are difficult to quantify.
- MPE is often limited by (1) lack of observation data and (2) limited time and resources for comprehensive evaluation:
  - MPE results are often summarized as seasonal means or averages over multiple monitor sites.
  - We need hourly spatial model-obs plots and time-series plots at each monitor site for O3 and other species.

EPA 2011 CMAQ Modeling

- BC data derived from GEOS-Chem.
- Larger set of rural O3 data available in 2011 from the Western States Air Quality Study.
- What can we learn from spatial patterns of model performance for hourly O3 data?
    - The expanded rural monitoring network is extremely valuable for model evaluation.

CMAQ biased low in morning at rural sites on May 30



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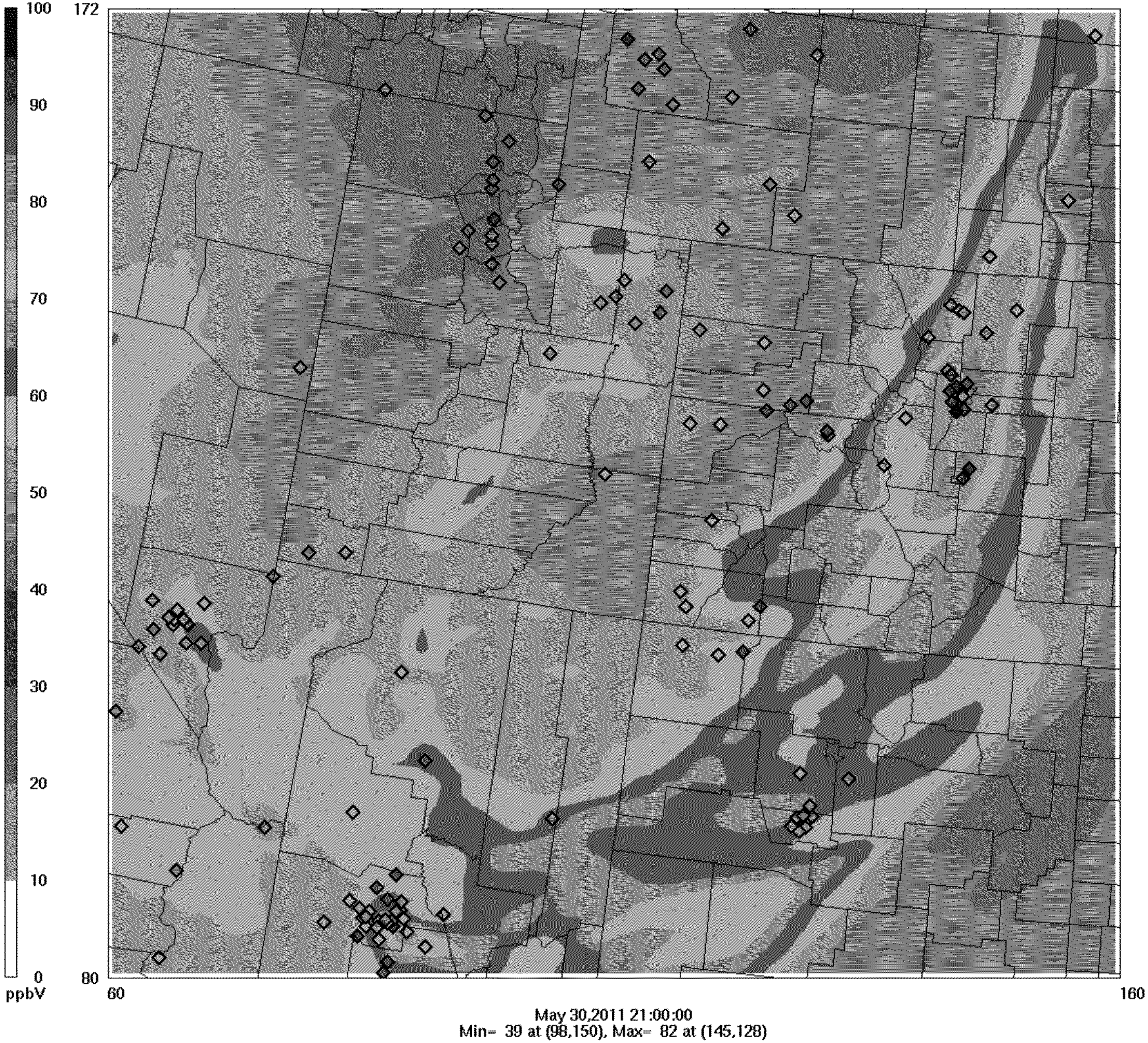
CMAQ matches the regional high O3 on May 30 but low bias at urban sites



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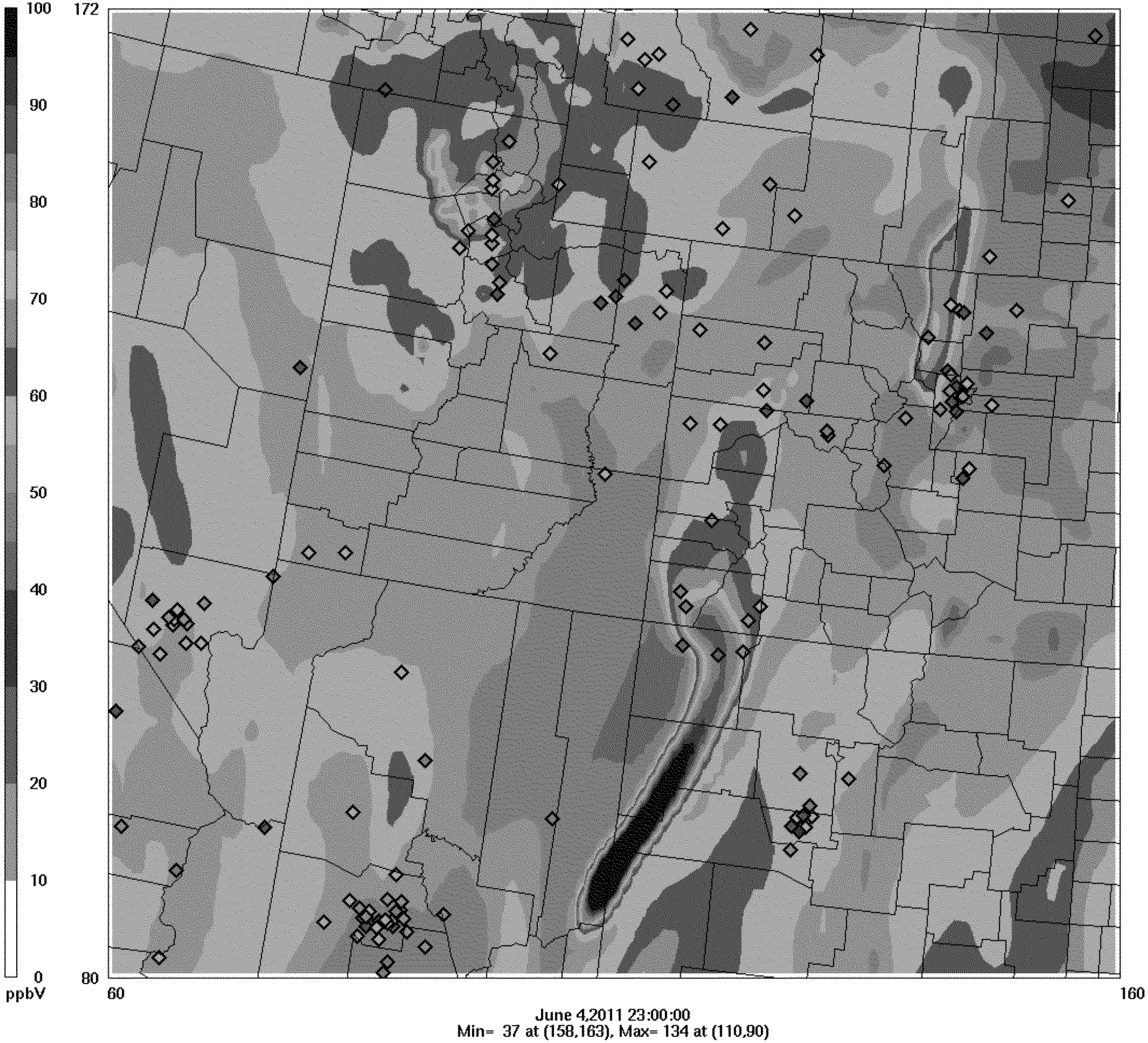
CMAQ biased high for wild fire O3 in June

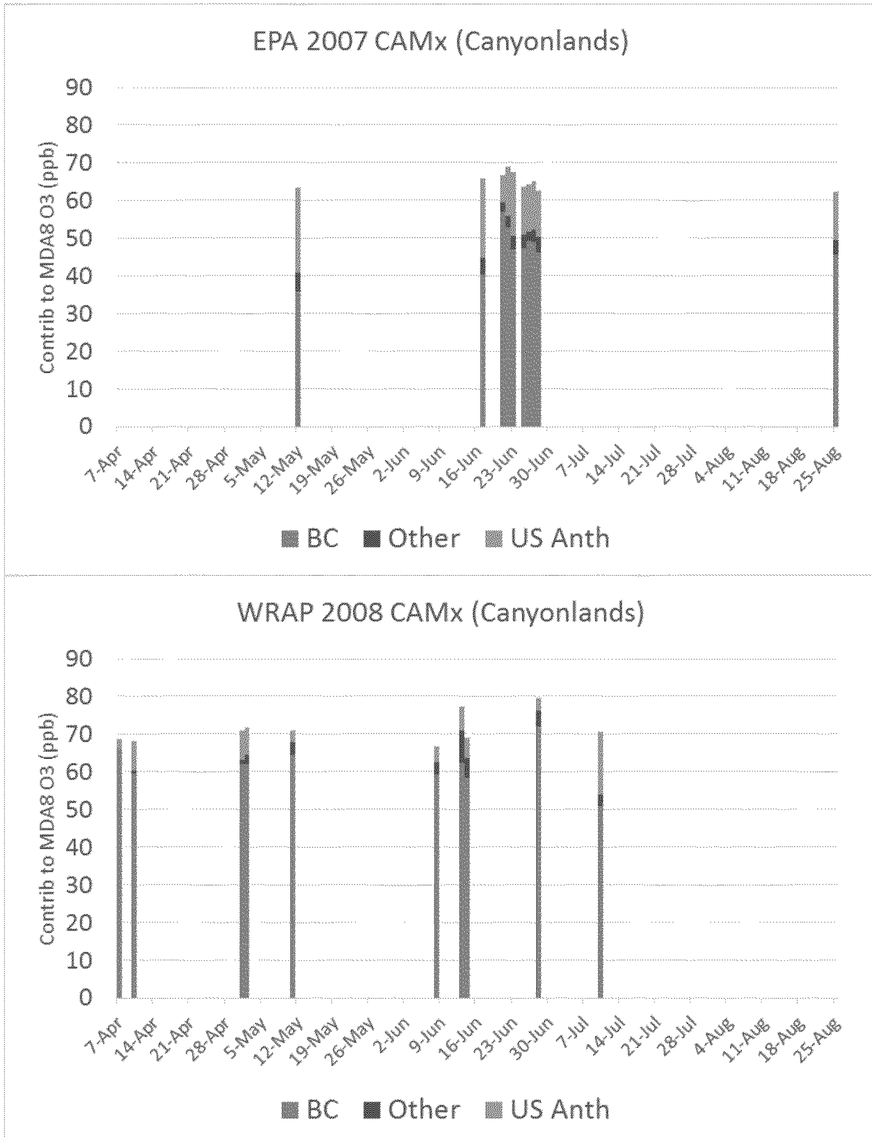


Source Apportionment for Regulatory Planning

- Source Apportionment is a high priority for regional ozone and regional haze planning. Need to quantify contributions from:
  - International biogenic and anthropogenic emissions.
  - US inter-state transport of O3 and PM2.5.
  - Stratospheric intrusions and wildfires.
- Global models need to be modified to include source attribution and to pass this information through the BC to regional models.
- How confident are we that coupled global/regional scales accurately represent source apportionment?
  - Need more rigorous process-level evaluation of models at all scales.
  - Need more resources for diagnostic and process-level MPE and model intercomparisons.

Uncertainty in model estimates of U.S. Background

CAMx simulations for 2007 and 2008 at Canyonlands National Park – Eastern UT

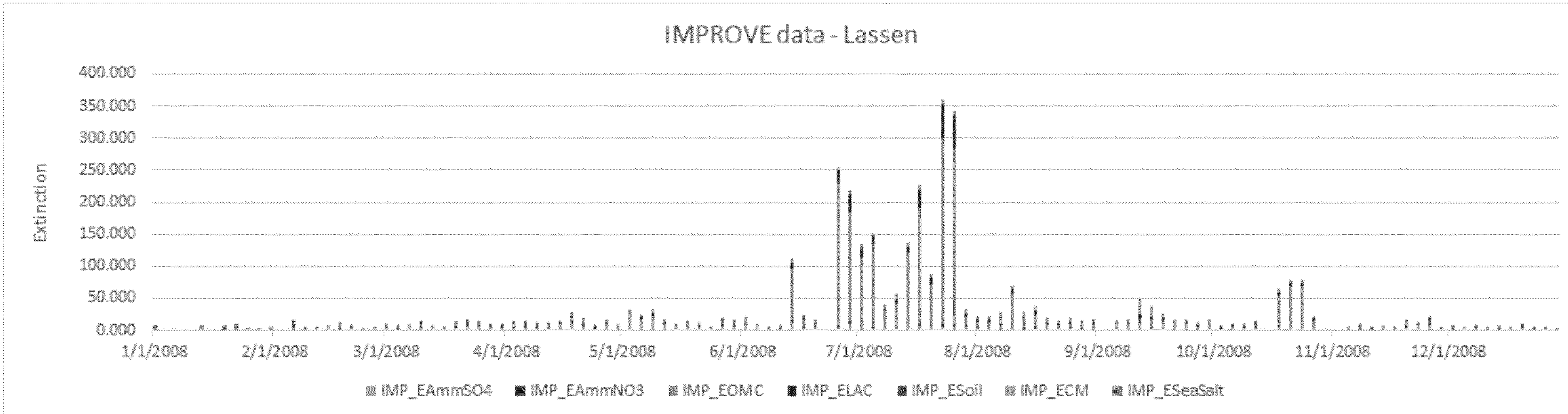


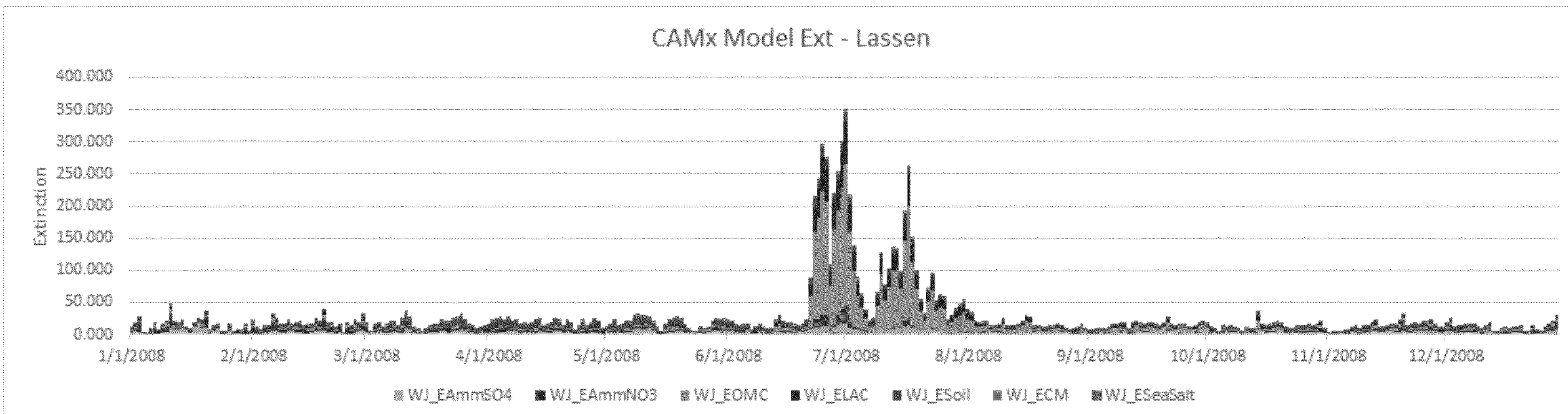
EPA 2007 CAMx model: BC contributions of 36-57 ppb; still substantial U.S. anthropogenic contribution to O3.

WRAP 2008 CAMx model: BC contributions of 50-72 ppb, much larger than OAQPS modeling.

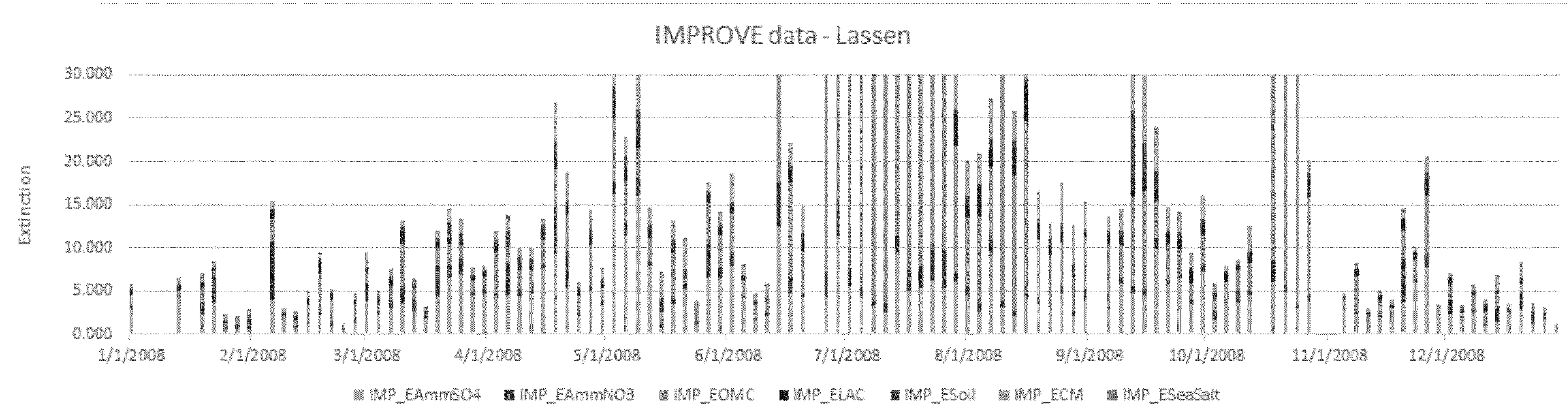
Reasons for modeled differences are not fully understood

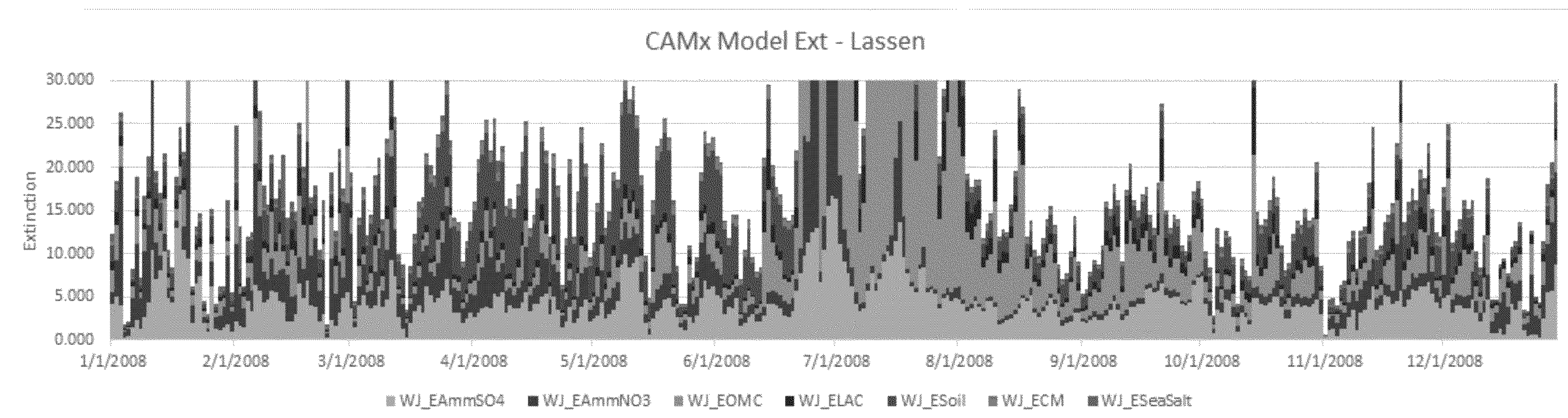
Lassen Volcanic National Park – speciated PM2.5 2008 IMPROVE data and CAMx model



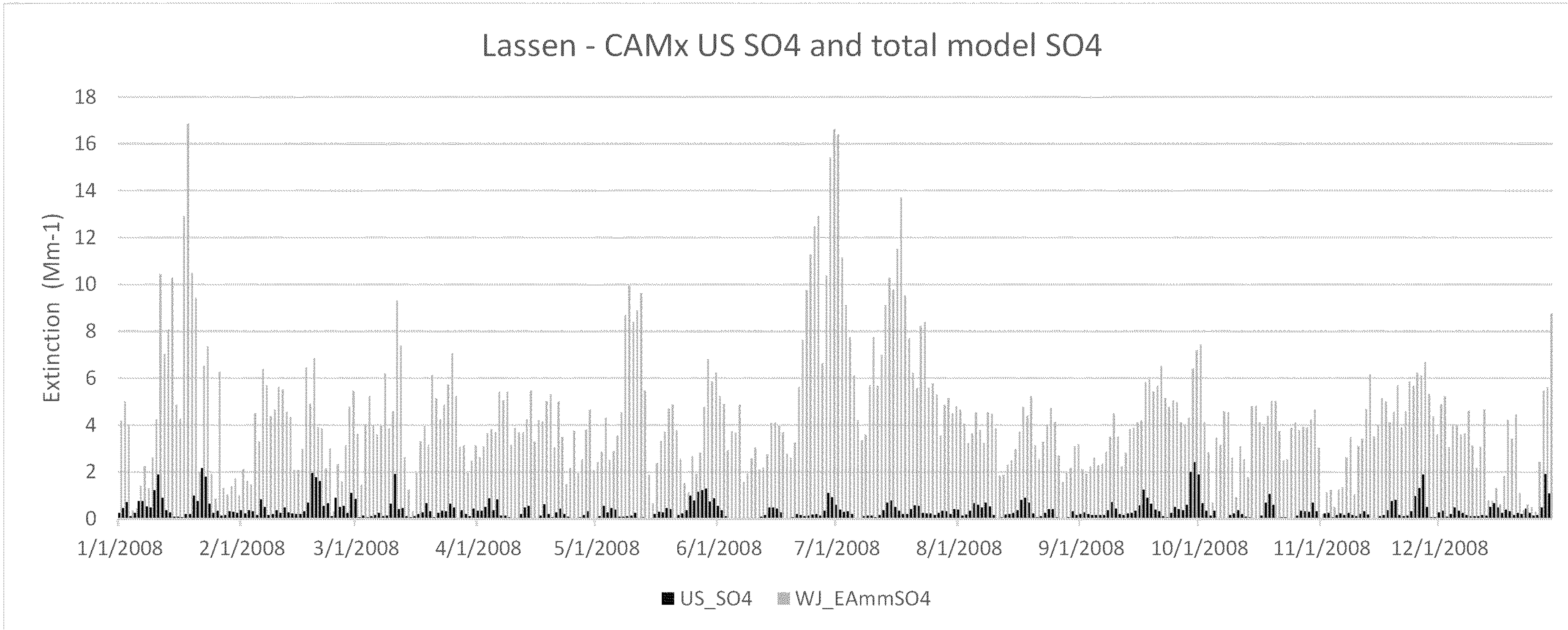


Lassen Volcanic National Park – speciated PM2.5
2008 IMPROVE data and CAMx model (y-scale truncated at 30 Mm^{-1})





Lassen Volcanic National Park – Sulfate source apportionment CAMx PSAT US anthropogenic sulfate versus total model sulfate



Sources of SO4 at Lassen (annual average)

BC inflow	71%
Fires	13%
US Anthro	9%
MX/CN/OS	4%
Biogenic	2.5%

How reliable are these model source apportionment estimates?

Key Technical Issues for Western US

- BC inflow is the largest contributor to haze and O3 at many rural sites. We need more comprehensive evaluation of the global models:
  - How accurate are the BC data derived from global models?
  - Need finer-scale global scale model simulations.
  - Perform more comprehensive episodic MPE for field study evaluation studies (CALNEX 2010; DISCOVER-AQ, 2011, 2014).
- Need more rigorous episodic MPE for regional scale models, i.e., focus on days most relevant to air quality planning.
- How well do models perform in the western US? Need day specific evaluation for:
  - International and Inter-state transport.
  - Stratospheric intrusions and Wildfire.
  - Rural vs. Urban.

Strategies for Improving the State of the Science for modeling in the western US

- Do we have sufficient monitoring data to evaluate model performance and analyze exceptional events?
- What additional monitoring would be most useful?
- Do we have sufficient resources to complete comprehensive global and regional scale model performance evaluations?
- How best can state, local and federal planners and researchers work together to perform monitoring, modeling and data analysis to support air quality planning needs?
    - Stratospheric intrusion work group is one example of collaborative work.

Extra Slides

Winter Oxidant and PM2.5 Planning Needs

- Health based PM2.5 NAAQS: 35 ug/m^3 24-hour average and 12 ug/m^3 annual average.
- Some PM2.5 winter non-attainment areas are caused by primary emissions of organic carbon from wood burning, but other areas are dominated by ammonium nitrate.
- Research is needed to develop better photochemical models of winter oxidants for PM2.5 and O3 nonattainment areas in California, Utah and Wyoming, and this will also have benefits for regional haze studies.